NORTHWEST & ALASKA FISHERIES CENTER PROCESSED REPORT

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POPULATION BIOLOGY OF THE BOWHEAD (Balaena mysticetus) AND BELUGA (Delphinapterus leucas) WHALE IN THE BERING, CHUKCHI AND BEAUFORT SEAS

By

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Abstract

Bowhead (Balaena mysticetus) and beluga (Delphinapterus leucas) whale distribution and abundance are summarized using data collected in 1976 and from the literature. Aerial and ice camp surveys were simultaneously conducted in an effort to delineate migratory patterns in the spring.

Spring 1976 census counts of whales near Barrow, Alaska, indicate that significantly fewer belugas than bowheads were seen using the ice camp counting method. Preliminary results reveal that aerial survey methods are better for delineating distribution, whereas ice camp counting methods will provide more reliable indices of population abundance.

An hypothesis is proposed delineating the spring migration of the bowhead whale in the Chukchi and Beaufort Seas: in the spring an unknown segment of the population migrates in off-shore leads north past Point Barrow, Alaska, to Banks Island, Canada, before entering the southeast Beaufort Sea in the summer. This modifies the existing hypothesis that the migration occurs near-shore along the north coast of Alaska.

Copulatory behavior and a young of the year bowhead calf were observed in early May 1976 near Point Barrow, Alaska, providing evidence that reproduction of the species occurs during the northward migration.

Fall concentrations of bowhead whales were observed in near-shore waters of the western Beaufort Sea. Reasons for this behavior are not yet clear. The coastal area from Smith Bay to Pt. Barrow should be closely studied prior to any oil or gas exploration.

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Introduction

This report is the culmination of the first year of research on the distribution and abundance of bowhead (Balaena mysticetus) and beluga (Delphinapterus leucas) whales in the Bering, Chukchi and Beaufort Seas, as part of the Outer Continental Shelf Environmental Assessment Program (OCSEAP).

The purpose of the report is to provide a summary of the current knowledge on bowhead and beluga whale distribution by integrating published and unpublished accounts with sighting data collected during 1976. Our intent is to provide a document which can be immediately transmitted to other scientists, managers and administrators who are in decision or policy-making positions.

Research on the bowhead whale at the Marine Mammal Division was initiated by Dale Rice in 1961-62, and was resumed in 1973 under contract with Floyd Durham (1975). The collection of biological data from animals harvested by Eskimos is an ongoing program at the Division (Fiscus and Marquette, 1975). Although Foote (in Mansfield, 1971) counted bowheads as they passed Pt. Hope during the early 1960's, to date there has been no systematic study of the numbers of bowhead and beluga whales which migrate within leads (cracks of open water in the ice) from the Bering Sea into the Chukchi and Beaufort Seas. It was principally because of this data gap that our research under the OCSEAP program was initiated.

Bowhead and beluga whales may be particularly vulnerable to the activities of oil and gas development because they migrate through the Chukchi and Beaufort Seas in near-shore leads along the coast of Alaska. Because both species are seasonally harvested, and because their population sizes are unknown, it is essential that they be intensively studied in order to determine their current status. With the exception of the Eskimo take, bowhead and beluga whales are protected under the Marine Mammal Protection Act of 1972 (MMPA). The bowhead is further protected under the Endangered Species Act of 1973. As such, private and public energy development groups are obligated to determine which, if any, energy-related activities might be detrimental to the species. To this end, we expect over the next several years to further delineate local movements, migration patterns, and abundance.

Our experimental plan for delineating distribution and abundance is to combine data collected by a counting team stationed on shore-fast ice near Eskimo hunters with data collected from aerial surveys. Sighting data from each survey method will then be compared to establish overlap, variability, and reliability.

This report is divided into six sections: Introduction, Current State of Knowledge, Study Area, Methods and Materials, Results and Discussion, and Conclusions and Recommendations. The Current State of Knowledge section provides a brief historical account of the available information on distribution and abundance from published and unpublished literature. The

Results and Discussion section provides more recent information on distribution, and estimates of how many bowhead and beluga whales passed near Barrow in 1976. This section also includes heretofore unsummarized data collected on bowhead whales by other scientists during 1974-1976.

Current State of Knowledge

Bowhead whale

From March through June bowhead whales migrate from the Bering Sea into the Chukchi and Beaufort Seas. They generally begin passing through the Bering Strait in late March and early April, as evidenced by our 1976 sightings and harvest records at Wales (Bailey and Hendee, 1926) and Point Hope (Johnson et al., 1966). At Barrow, Alaska, the arrival of animals can vary by two weeks in late April to early May (Maher and Wilimovsky, 1963; Foote, 1964; Fiscus and Marquette, 1975), depending upon ice conditions. Migration in the southeastern Chukchi Sea has been described as occurring in "waves". The first and second waves are believed to be sub-adults; the third wave is comprised of adults (Maher and Wilimovsky, 1966; Durham, 1975). This assumption is primarily based upon Eskimo whaling statistics (Marquette, 1976). The end of the migration period past the northwest coast of Alaska (Pt. Hope and Barrow) is unknown, as ice conditions prevent observers from staying on the ice past early June. By mid-May bowheads begin arriving in the Canadian Arctic, first near Banks Island, and later near the Mackenzie River delta, where they remain through the summer (Sergeant and Hoek, 1974; Fraker, 1977).

Spatial distribution of whales from early June through August in the western Beaufort Sea is poorly documented. Fiscus and Marquette (1975) recorded that the first catch of the fall Eskimo whaling season is in September. Hence, bowheads may be absent from the western Beaufort Sea during the summer. Early commercial whaling records indicate that July through September was the favored time to hunt bowheads in the northern Bering-southern Chukchi Seas and eastern Beaufort Sea (see Cook, 1926; Bodfish, 1936; Starbuck, 1964; Bockstoce, 1977; Fraker, 1977). Mansfield (1971) briefly summarized the distribution of bowheads in the western Canadian Arctic, near Banks Island, using recent sighting records.

The spring migration route east of Barrow is poorly defined. Also, it is unclear what percentage of the total population moves past Barrow. Perhaps some animals remain in the northeastern Chukchi Sea throughout the summer.

The size of the bowhead whale population in the Bering Sea and Arctic Ocean prior to commercial exploitation is open to conjecture. Townsend (1935), Hegarty (1959) and Starbuck (1964) list information concerning commercial whaling prior to 1920, including names of vessels and dates of departure and return, number of whales taken per ship, and the waters where each vessel whaled. Comparing harvest records from Townsend (1935) and Starbuck (1964), the bowheads taken prior to 1850 were undoubtedly from the Atlantic Ocean populations, and those taken after 1850 were predominantly from the Bering Sea population. Scammon (1874) indicates that whalers first searched for bowheads in the Bering and Chukchi Seas in 1847-48.

Using Townsend's (1935) data as a sample of the total bowhead catch from the Bering Sea and Arctic Ocean, an assessment of the relative size of the early population can be made. Figure 1 is a histogram of Townsend's records. It depicts the trend in the number of bowheads taken by commercial whalers (histogram), and includes an overlay graph of the whaling effort. In just 25 years (1850-1875), the number of bowheads harvested per five year interval declined 82%, whereas the whaling effort declined 33% (Figure 1). Such a rapid decrease in the number of whales taken suggests that the size of the pre-exploited population was not large. This is also suggested by the fact that the annual harvest from 1875 to 1919 remained almost constant while the effort fluctuated (Figure 1). The dramatic increase in catch per unit effort from 1890-1904 was a result of more efficient whaling with the introduction of the steam ship whaler (Bockstoce, 1977).

Assuming a stable population, Rice (1974) estimated the western Arctic Ocean and Bering Sea bowhead population to be 4,000-6,000 animals between 1868 and 1884. It appears now that this was not a likely assumption (Figure 1). Since early whaling records have not been systematically investigated, no reliable estimate can be made of the pre-exploited population level of bowheads in the Bering Sea and western Arctic Ocean using Townsend (1935).

Current stock assessments have been made by Sergeant and Hoek (1974), who estimate the number of bowheads in the Beaufort Sea to be "in the low hundreds". In August and September of 1976, Fraker (1977) sighted about 80 animals (probably includes duplicates) north and east of the Mackenzie delta area in the eastern Beaufort Sea.

Bowhead whales are believed to feed on copepods, amphipods and euphausiids. Species identified in whale stomachs from these groups include: *Calanus hyperboreus*, *Parathemisto libellula*, *Thyanoessa inermis* and *T. rauschi*.

Beluga whale

The beluga whale (also known as the belukha and white whale) is usually found in shallow bays or estuaries north of 40° N. Latitude. In Alaskan waters there are at least two resident populations: one in Cook Inlet consisting of perhaps 300-400 animals, and the other in eastern Bristol Bay numbering 1,000 to 1,500 individuals (Klinkhart, 1966). The population size north of Bristol Bay may reach 8,000 individuals (DEIS, 1976). Belugas begin their northward migration to arctic waters in March and April, travelling in groups as large as 100-600 (Bailey and Hendee, 1926; Kleinenberg et al., 1964; Johnson et al., 1966). Locations in the Bering Sea from which belugas migrate are not clear. In the western Canadian Arctic the summer-fall population reaches 4,000-6,000 animals (Sergeant and Hoek, 1974; Fraker, 1977).

elugas follow leads in the pack ice which extend into the Bering Sea and Arctic Ocean. Once through the Bering Strait, some animals are reported to ove along the Siberian coast (Kleinenberg et al., 1964), while others follow he Alaskan coast (Sergeant and Hoek, 1974; Sergeant and Brodie, 1975). We o not know what percentage of the population moves into the western Chukchi r the Beaufort Seas.

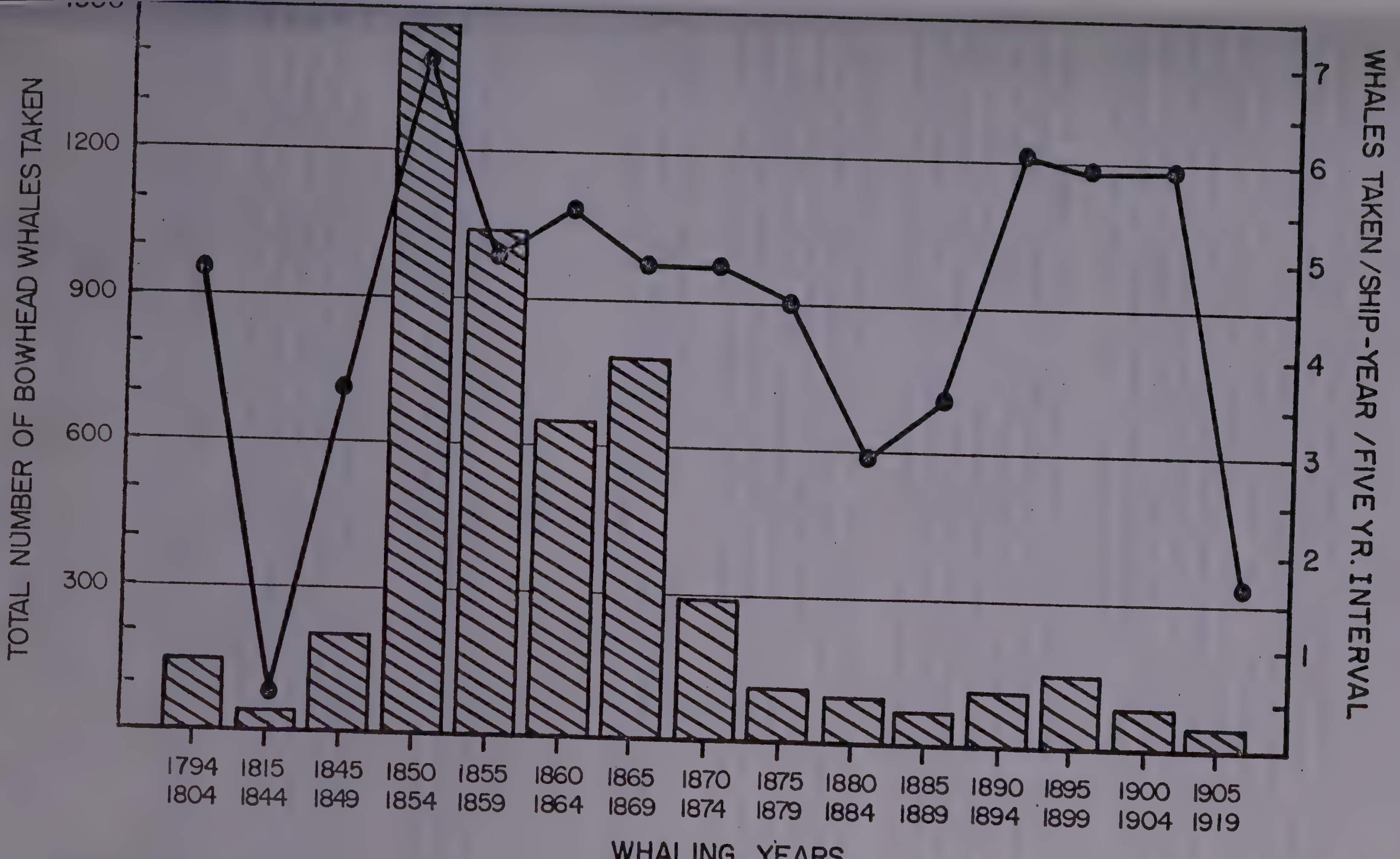


Figure 1. Chronological account (histogram) of the bowhead whales taken by commercial whalers, 1794-1919. Records prior to 1850 are considered Atlantic Ocean data; after 1850 they are considered Bering Sea-Arctic Ocean data. The data are pooled into five year intervals because of overlapping ship cruises. Whaling effort is reported as whales taken per ship per five year interval. These data, extracted from Townsend (1935), represent an unknown fraction of the total number of bowhead whales taken for all years from the Atlantic Ocean and Pacific Ocean populations.

Depending upon ice conditions, the first belugas are reported to appear off Pt. Hope in late April (Fiscus and Marquette, 1975) although sightings exist in the northern Bering and southern Chukchi Seas during February and March (Kleinenberg et al., 1964; authors, pers. obs.). Belugas are believed to move north as late as July, as evidenced by hunting records at Pt. Hope (Foote and Williamson, 1966). By May and June, some belugas reach the eastern Beaufort Sea near Banks Island (Sergeant and Hoek, 1974), and the eastern Siberian coast (Klinkhart, 1966). It is unclear what portion of the population arriving at Banks Island comes from Alaskan waters. Fraker (pers. comm.) feels that many belugas winter in eastern Canada.

During the summer and fall belugas enter river estuaries as soon as the ice moves offshore (Klinkhart, 1966; Fraker, 1977). On 24 June, 50 belugas were observed at the mouth of the Pitmegea River just northeast of Cape Lisburne (Childs, 1969, in AEIDC). In Kotzebue Sound during the fall, belugas have been reported near Sheshalik, across Hotham Inlet north of Kotzebue (Foote and Williamson, 1966). The species is believed to breed and calve in southeastern Kotzebue Sound (U. S. Department of the Interior, 1974, in AEIDC).

For those animals wintering in Alaska, the fall migration west from the Mackenzie River delta commences in September (Sergeant and Hoek, 1974); however, the precise route and direction of travel is unclear. Movement probably precedes the fall freeze-over (LeResche and Hinman, 1973) since belugas are not able to maintain breathing holes in thick ice, and are probably not capable of swimming long distances underwater (Fraker, 1977).

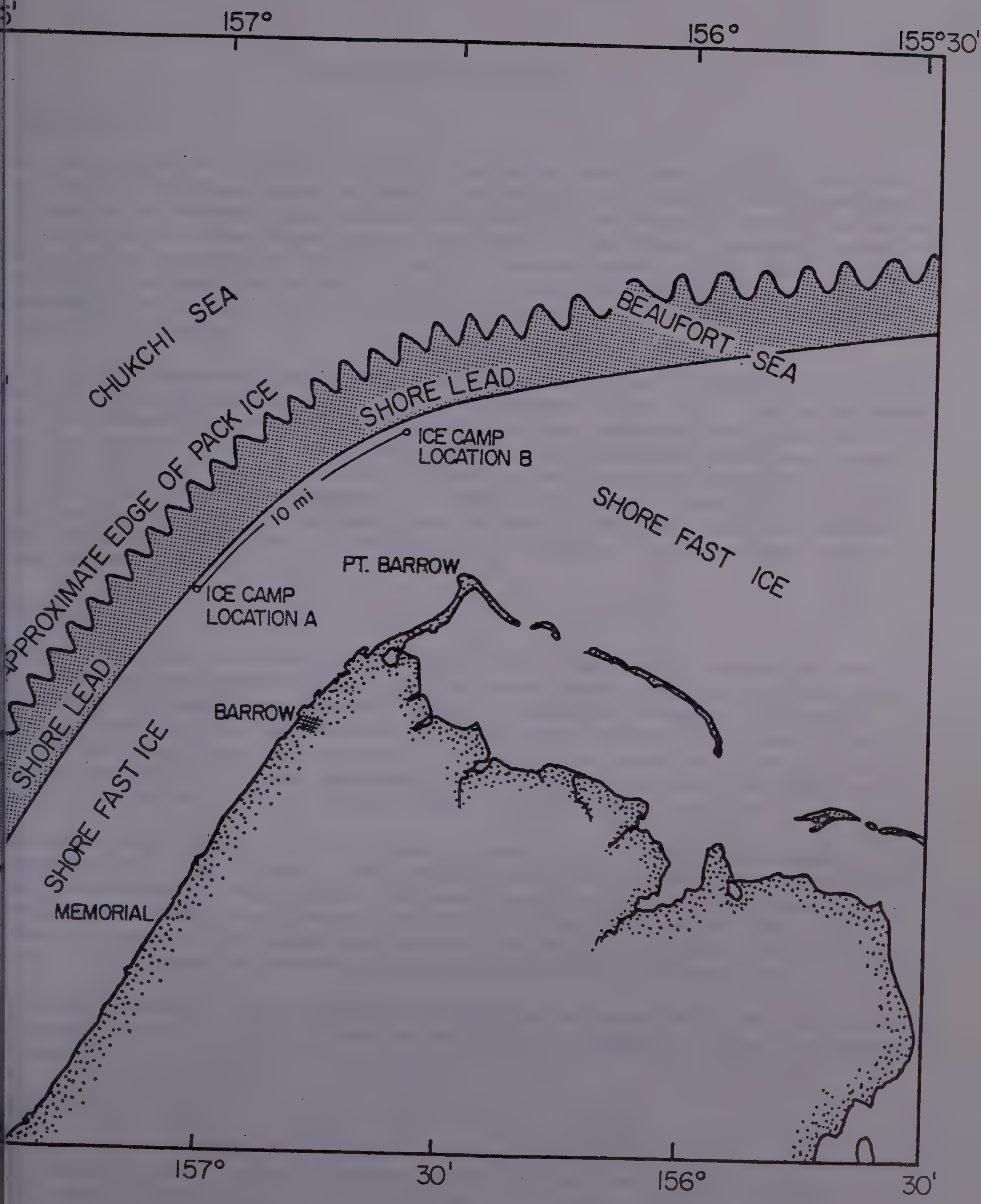
Klinkhart (1966) records a seasonal shift in feeding habits of belugas. While offshore in the Arctic Ocean these animals presumably feed on a variety of fish, especially arctic cod, crustaceans and squid (Sergeant and Hoek, 1974).

Study Area

The study area includes the Bering Sea north from St. Lawrence Island and east of the US-USSR 1867 Convention line, north into the Chukchi Sea to approximately 72° N. Latitude, and east into the Beaufort Sea to the US-Canadian border at 141° W. Longitude.

Aerial surveys in the Beaufort Sea took place within 50 km of shore, because we thought that open water leads did not normally occur far from land. In the Chukchi Sea, however, surveys were flown offshore to delineate leads. The most heavily surveyed area of the Arctic Ocean was between 69° N. Latitude and 72° N. Latitude to within a few kilometers of shore.

The whale counting camps were located on shore-fast ice: one approximately eight miles northwest of Pt. Barrow and the other eight miles west of the village of Barrow (Figure 2).



e 2. Study area map of bowhead and beluga whale census camps on the shore-fast ice northwest (Location A) and north (Location B) of Barrow, Alaska. The location of the shore lead in the Beaufort Sea is approximate, occurring closer to shore as the distance from Pt. Barrow increases to the east.

Materials and Methods

Aerial survey

Aerial surveys over the pack ice and open leads were conducted at elevations of 200 to 1,000 feet depending upon cloud conditions. The aircraft used was a twin engine Grumman Otter, chartered from the Naval Arctic Research Laboratory. An On-Track II navigational system, available in the Otter, provided a means of locating our position to within 1 nmi^2. This equipment allowed us to determine precisely the position of each sighting. Also, the On-Track II was used to determine the position of the ice camps in relation to the shore, for later plotting on charts.

Two to three observers were used, each acting as his own recorder, noting the details of each sighting, including environmental conditions. The pilot proved to be a valuable spotter. Communications between observers were poor, but will be improved in 1977 with the addition of an intercom system (see Braham et al., 1977). One observer sat in the co-pilot's seat and acted as the "chief spotter" and photographer. A single lens reflex 35 mm F2S Nikon camera was used to take the photographs, with 105 and 135 mm lenses and high speed Ektachrome film (ASA 160). [Reference to trade names does not imply endorsement by NMFS, NOAA.]

Ice camp

Counts of bowhead and beluga whales were made by observers standing on the ice next to the near-shore lead. As the whales moved past the observers, the following information was scored: number of animals, direction of travel, general behavior, approximate size of each animal, weather conditions, time of day and, when possible, length of time animal(s) spent at the surface and duration of dive. One and sometimes two observers stood watch for four to six hours rotating on a 24 hour basis between 25 April and 2 June 1976.

Two camps were used during the season (Figure 2), but were simultaneously occupied only once (13 May). One camp was used when ice conditions near the other were unsafe. The southern ice camp (Location A) was used primarily early in the season (April-May) and the north camp (Location B) later (May-June) (Figure 2). The camps were located 1/4 to 1/2 mile shoreward from the lead, which placed the observer(s) some distance from the base camp.

Working in concert, the ice camp and aerial survey teams maximized our chances of providing the geographic coverage necessary to delineate bowhead and beluga movements.

aboratory

system was developed for logging, checking, editing and final processing of he sighting data. A description of the procedures and a flow diagram of the our-phase program are included in Fiscus and Braham (1976).

Results and Discussion

erial survey and ice camp sighting data for the spring 1976 field season re summarized chronologically in Table 1. Observations totalling 422 hours ere made from the ice camp during 30 survey days (average 14 hours/day) and pproximately 93 hours were spent flying during 19 survey days (average 5 ours/day). The aerial survey tracklines are summarized in Figure 3.

owhead whale

pring 1976 counts. There were 357 bowhead whales observed migrating by the ce camp from 25 April to 2 June 1976. Some 259 whales were seen by the ice amp census crew (73%), and 98 were seen by Eskimo hunters stationed by our amp (Table 1). Eskimo sightings were independent from ours, but were included n the total count if the following criteria were met:

1. The Eskimos reported a whale passing our camp unseen by us.
2. The Eskimos were seen pursuing a whale up or down the lead from our camp, and we were sure that the animal had not been seen by us.
3. A shot was fired at a whale we had not seen.
4. Some of the Eskimos became excited over the observation of a whale made by other Eskimos, and we were sure that the animal had not been seen by us.

s the season progressed, and our census crew became more experienced, the roportion of whales seen by our crew to that seen by the Eskimos increased Figure 4).

he mean number of bowheads seen per hour by observers stationed in the ice amp was 0.61 (standard deviation = 2.73), n=30, or 0.85 (SD = 3.04), n=30 f the Eskimo sightings are included in the total. From these two values n estimate of 571-796 bowhead whales passed our ice camp in the nearshore ead between 25 April and 2 June 1976. This estimate applies only to the ime interval of 25 April to 2 June (i.e., 936 hours X 0.61 = 571; 936 hours 0.85 = 796), and should be thought of only as an index to the number of owheads that passed the ice camp. Whales were observed moving by Barrow rior to the initiation of our ice study, and whales were still moving by t least until 20 June when the last aerial survey was conducted.

he accuracy of the estimate certainly is affected by that proportion of hales which moved by the ice camp but were not detected. The probability f detecting whales which moved by within 2 miles of the camp is quite high, probability which is based on intuitive feelings of ice camp observers. nimals passing farther offshore probably go undetected. Concurrent aerial rveys flown offshore, west of Barrow, did not reveal any use of offshore eads by bowheads (Figure 5). East of Point Barrow, bowheads were seen in eads farther offshore (Figure 5).

Table 1. Number of bowhead and beluga whales sighted by the ice station counting crew, by Eskimos, and by the aerial survey team. See text for an explanation of the Eskimos' role in the counts. Dashed spaces indicate no surveys took place.

Date	Number of Bowheads			Number of Beluga	
	Ice Crew	Eskimos	Aerial Crew	Ice Crew	Aerial Crew
25 April	3	2	-	0	-
29 "	11	6	4	0	248
30 "	7	10	-	0	-
1 May	17	3	6	0	48
2 "	3	6	-	0	-
3 "	1	1	3	0	67
5 "	11	9	-	0	-
6 "	16	19	-	0	-
7 "	8	1	-	0	-
8 "	4	1	34	0	85
9 "	2	0	5	0	27
0 "	0	1	-	0	-
1 "	0	0	-	0	-
2 "	0	0	2	0	0
3 "	21	7	-	0	-
4 "	5	0	-	0	-
5 "	11	3	18	0	134
6 "	18	11	-	2	-
7 "	26	9	-	0	-
8 "	52	9	-	100	-
9 "	1	0	3	0	8
0 "	-	-	0	-	20
1 "	4	0	-	0	-
2 "	19	0	4	207	129
3 "	0	0	-	0	-
4 "	9	0	3	0	1
5 "	1	0	-	0	-
6 "	6	0	-	0	-
8 "	-	-	1	-	0
"	1	-	4	0	1
June	1	-	3	0	144
"	1	-	-	0	-
"	-	-	15	-	35
"	-	-	2	-	0
"	-	-	0	-	12
"	-	-	1	-	61
"	-	-	0	-	0
Totals	259	98	108	309	1,020

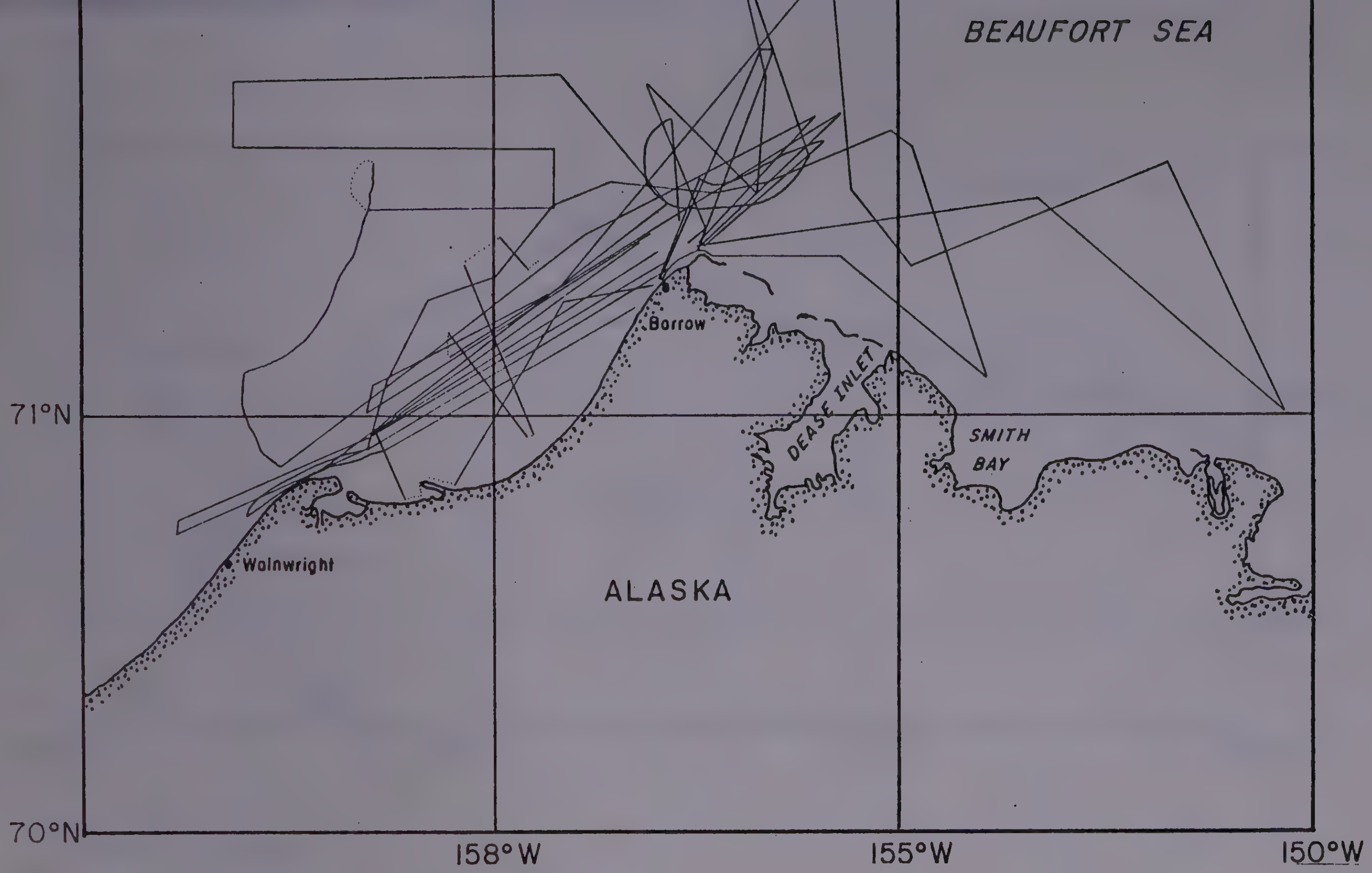


Figure 3. Aerial survey tracklines during spring 1976 bowhead and beluga whale research, conducted from the Naval Arctic Research Laboratory, Barrow, Alaska.

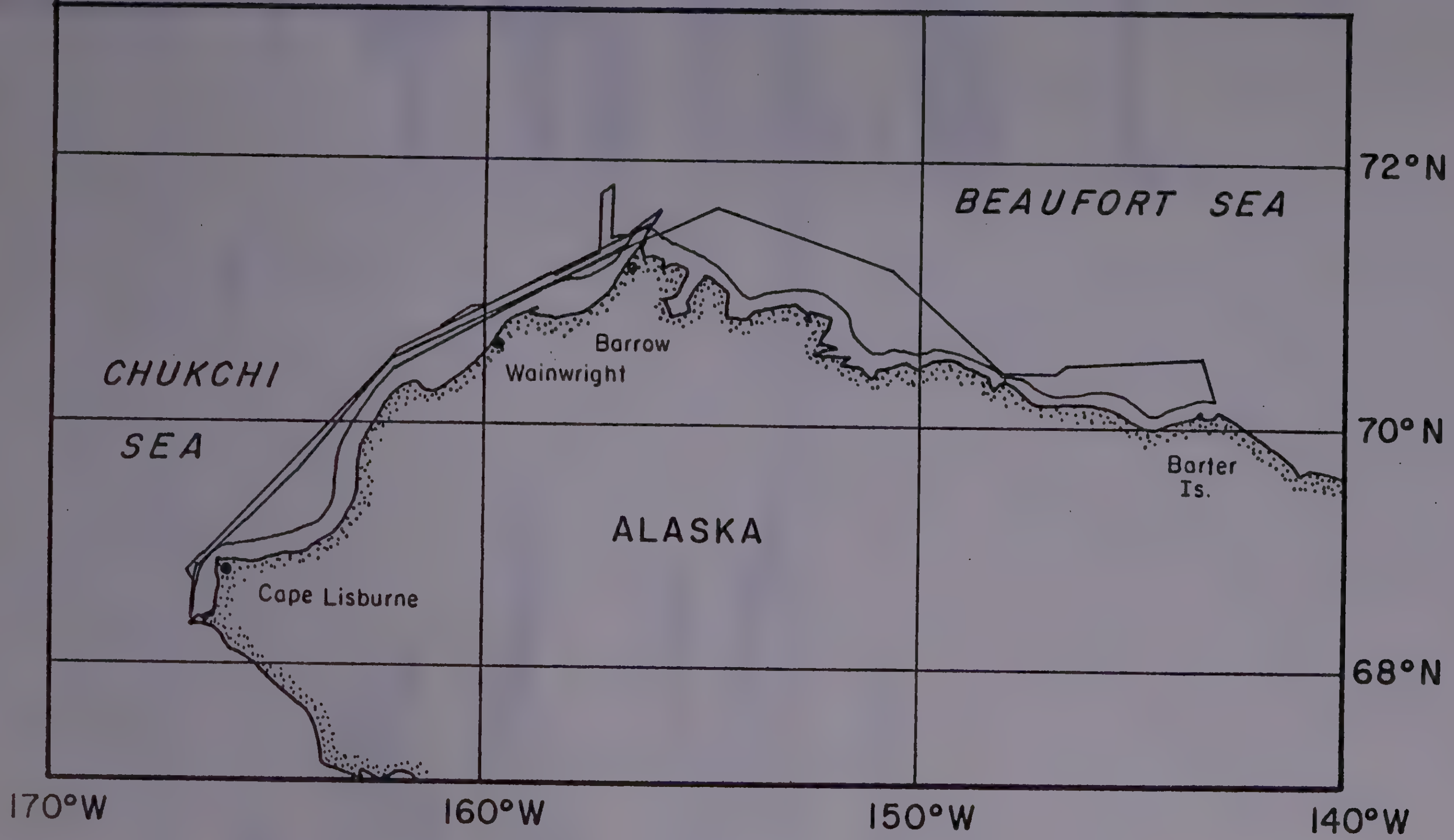


Figure 3, continued.

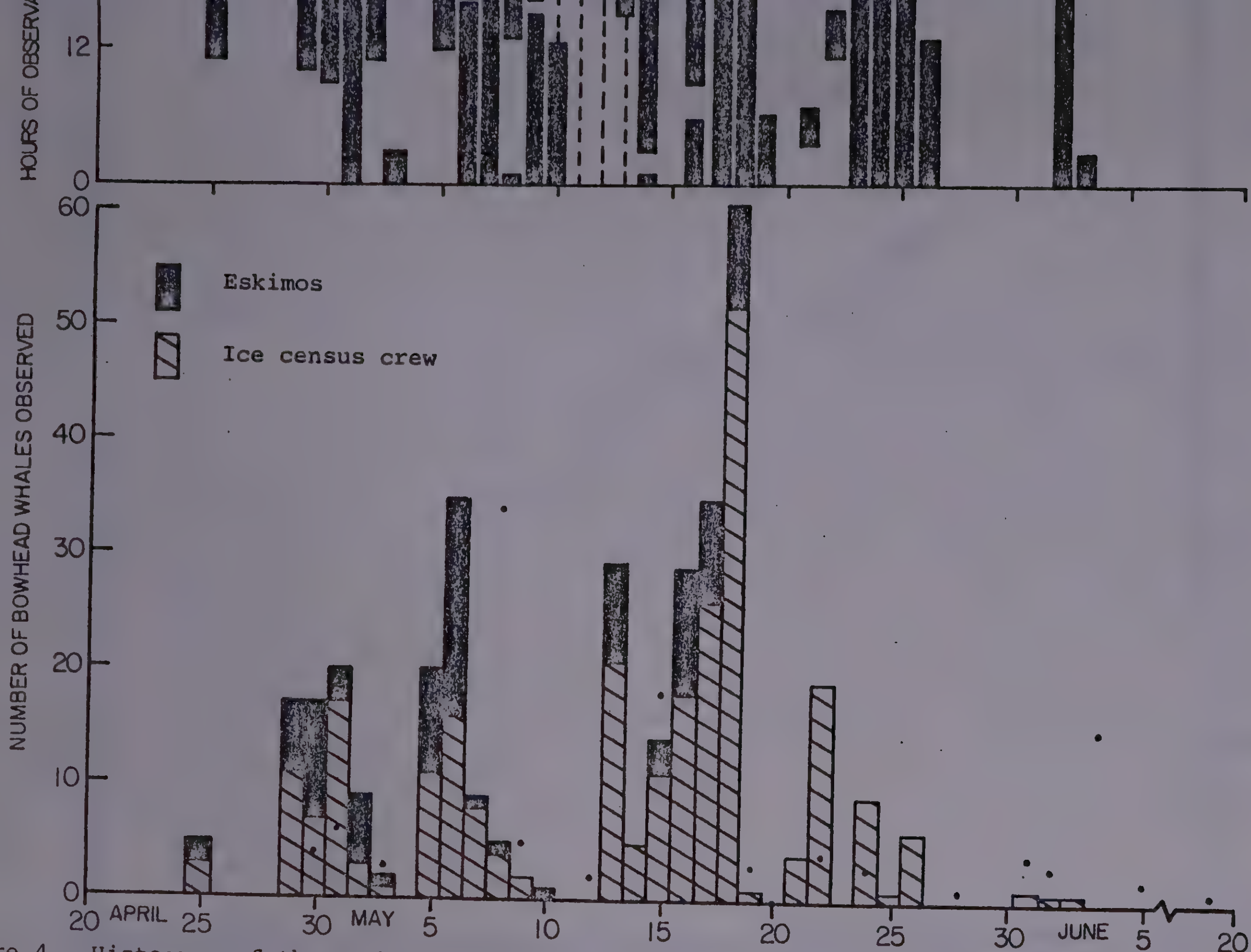


Figure 4. Histogram of the numbers of bowhead whales observed along the shore-fast ice lead at Barrow, Alaska, 1976. Sightings are related to the hours in the day when the census crew was observing. Dots (·) indicate the number of bowheads seen by the aerial survey team on that date. Dashed lines indicate an intermittent watch effort.

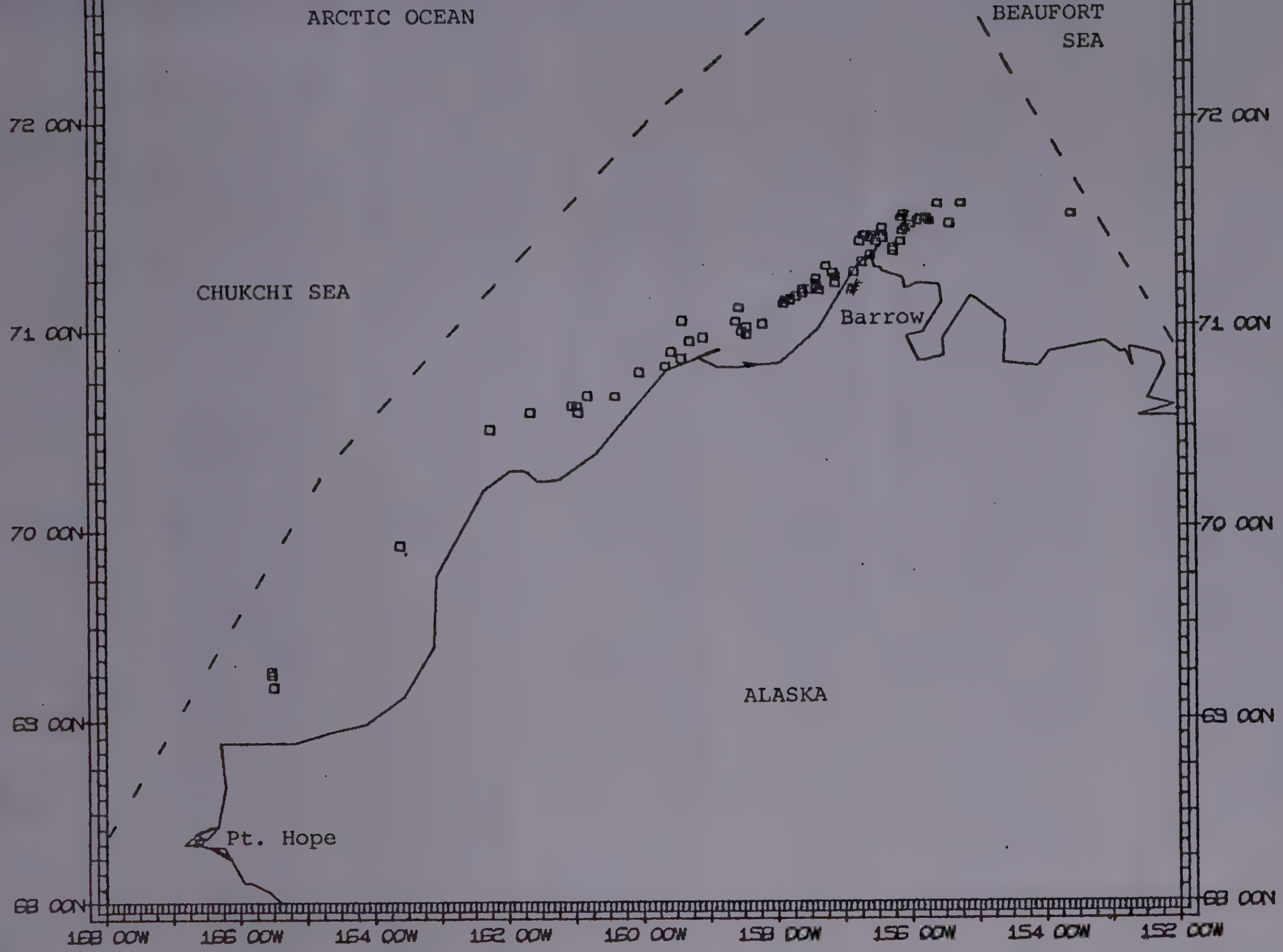


Figure 5. Spring 1976 aerial survey sightings of bowhead whales, *Balaena mysticetus*, along the northwest coast of Alaska. Dashed line represents the maximum extent of offshore aerial surveys.

ovement of bowheads through a lead system may be related to the opening and losing of the lead. Results based on ice camp counts suggest that animals ay somehow "bunch up" when a lead closes, and resume migration when the lead eopens. Small peaks in the number of whales moving by Barrow occurred on 30 pril and 1, 6, 13 and 22 May (Figure 4). Following each peak, there was a radual drop off in the number of bowheads passing the ice camp. Preceding ach peak, the lead was essentially closed for one or more days. This pattern s precisely the one to expect if migrating animals were being stalled by the losing of the lead.

he rapid build-up and peak in numbers on 18 May conceivably was the result of large scale closing of the lead southwest of Pt. Barrow. With the re-opening f the lead, bowheads could resume their migration. Through the telescoping ffect of animals moving from areas of higher to lower density (newly opened ead), the major pulse of the animals moving by any one observation point would ppear as a rapid increase and peak. The appearance of this pulse would be actly opposite of the pulse created by local closures of leads.

ch of the above discussion is conjecture, but we do have direct evidence at whales group at the end of leads which have closed. Large groups of imals were observed during aerial surveys (e.g., 8 and 15 May, Figure 4) in lead which was closed northeast of Pt. Barrow.

me of the fluctuations in the data (Figure 4) are undoubtedly the result of mporal migratory patterns. The large number of animals observed 12-18 May n also be explained as a peak in migration. Temporal movements on a diurnal ale were investigated by comparing the hourly rate of animals seen in the M. (0001-1200) versus the P.M. (1201-2400). No difference was found, which ggests that there is no diurnal periodicity. This point needs further study.

e number of animals seen per hour throughout the entire period shows that e maximum rates occurred on 15, 18 and 22 May, shortly after the lead had pened. The number per hour seen later in the season (23 May - 2 June) was out half (0.23 animals/hour) of that seen earlier (29 April - 8 May) when e average number seen was 0.50 per hour. From 13 to 22 May, the lead opened closed four times, resulting in four associated sighting peaks.

tribution. Aerial survey and ice station sightings show that the majority %) of the bowheads migrating past Barrow in 1976 did so during the middle rd of the survey period (9-18 May). This result may be significant because, the bowhead migration pattern displays a narrow temporal peak throughout the mal's range (i.e., from the Bering Sea to the Beaufort Sea), then a large ment of the population could be vulnerable to oil development activities hin a short period of time.

er aerial survey sightings were made near the shore of the western Beaufort than along the coast of the eastern Chukchi Sea (Figure 5). (Note: Point row is considered the dividing line of the two Seas.) Although weather tricted surveys along the northern coast (Beaufort Sea), more of our off- e sightings were northeast of Point Barrow than west of Barrow. This ference suggests that the easterly migration past Pt. Barrow is farther shore.

There were very few spring 1976 bowhead whale sightings reported to us from outside the Barrow study area. Eleven (11) sightings from the southern Chukchi and Bering Seas were submitted (Table 2). Several independent observers reported seeing up to four bowhead whales in the western Bristol Bay-St. George Basin areas in April (Table 2). Whaling records in Townsend (1935) suggest that few bowheads were taken in the southeastern Bering Sea. The 1976 sightings thus confirm the probable southeastward extent of the bowhead range. The remaining sightings were essentially in the western Bering Sea within the suggested migration route of the species (Table 2). The two animals seen in the Chukchi Sea on 12 June (Table 2) were not actively moving north. Townsend's (1935) plots of bowheads in the southern Chukchi Sea from June to August suggest that a protracted migration occurs. Many animals were taken during the summer north and south of the Bering Strait (Townsend, 1935) suggesting that animals were still migrating north as late as July or August. he peak migration period of the bowhead, then, appears to be from March through uly.

all sightings. Bowhead sighting data during the fall are minimal. Clifford iscus sighted bowheads near Cape Simpson between 12 and 22 September 1974. he highest number he saw was 57 on 18 September 1974. Only two bowheads ere seen during the fall 1975 surveys, because of poor ice and weather onditions. Between 16 and 26 September 1976, Robert Everitt sighted over 00 bowhead whales in the same general area as those seen in 1974 (southeast f Pt. Barrow). The greatest number seen during a single day was 47 on 21 eptember 1976. These sightings suggest that the area from Smith Bay to Pt. arrow represents a very important congregation site for bowheads prior to eir southward migration. This apparent "critical habitat" is presented in gure 6.

ghting records from other OCSEAP contractees have been sent to us. In gust 1975, Dr. Carleton Ray (pers. comm., RU 34) sighted 74 bowheads north-st of Icy Cape (about 70°30' N. Latitude, 161°00' W. Longitude). He also served large concentrations of bowheads between Smith Bay and Pt. Barrow and, October 1975, saw six bowheads in the Chukchi Sea at about 70°30' N. Latitude, 3°-169°30' W. Longitude. Data collected by Ray in 1975 would suggest that cause of heavy ice in that year, bowheads began their southward migration rlier than in 1974 and 1976.

hough the data are sparse, they suggest that bowheads move west and south om Pt. Barrow during the fall, probably in September. We have, as does Ray ers. comm.), sightings that place bowheads at three locations during September: east along the northern coast of Alaska within 100 km of Pt. Barrow; 2) south Barrow along the coast to Peard Bay; and 3) west some 100 km into the kchi Sea.

zin (pers. comm.) reports seeing bowhead whales on the Soviet side of the USSR 1867 Convention line, 8-11 October 1974 and 1975 (Table 3). Cook (1926) cribes taking bowheads near Herald Island (USSR); and Townsend's (1935) plots icate that the summer-fall range of the species extended to Wrangell Island SR).

Table 2. Summary of the number of bowhead and beluga whale sightings in the Bering and southern Chukchi Seas by date from aerial (A) or vessel (V) surveys during 1976. The general location of each sighting and the individual or survey group reporting the data are included. RU 67 or 69 denotes the OCSEAP research team conducting the survey.

Date	Species	Number of Animals	General Location	Survey	
				Type	Observer
5 March	Beluga	8	N. Bering Sea	A	RU 69
8 "	Beluga	18	N. Bering Sea	A	RU 69
9 "	Beluga	2	N. Bering Sea	A	RU 69
9 April	Beluga	33	E. Bristol Bay	A	RU 67
9 "	Bowhead	1	W. Bristol Bay	A	J. Hall[1]
4 "	Bowhead	1	W. Bering Sea	A	G. Fedoseev[1]
5 "	Bowhead	1	S.W. St. Matthew Is.	A	G. Fedoseev
8 "	Bowhead	1	W. St. Lawrence Is.	A	G. Fedoseev
9 "	Bowhead[2]	2	W. Pribilof Is.	V	P. McGuire[1]
9 "	Bowhead	1	E. St. Lawrence Is.	A	RU 67
9 "	Beluga	4	E. St. Lawrence Is.	A	RU 67
9 "	Beluga	79	N.W. St. Lawrence Is.	A	C. Ray[1]
0 "	Bowhead[2]	2	W. Pribilof Is.	V	P. McGuire
0 "	Bowhead	1	N.W. St. Lawrence Is.	A	RU 69
0 "	Beluga	4	N. Bering Sea	A	RU 69
1 "	Bowhead[2]	2	W. Pribilof Is.	V	P. McGuire
"	Bowhead	2	S. Bering Strait	A	RU 69
"	Beluga	118	S. Chukchi Sea, N. St. Lawrence Is.	A	RU 69
"	Beluga	25	N.W. St. Lawrence Is.	A	RU 69
"	Bowhead	1	W. Bristol Bay	A	J. Burns[1]
"	Beluga	1	N.E. Norton Sound	A	RU 69
May	Beluga	10	W. Bering Sea	A	G. Fedoseev
"	Beluga	2	W. Bering Sea	A	G. Fedoseev
June	Bowhead	2	S. Chukchi Sea	A	RU 69
"	Beluga	18	S.W. Norton Sound	A	RU 67
August	Beluga	4	W. Norton Sound	A	RU 67

John Burns, Alaska Dept. of Fish and Game, Fairbanks, AK
Genadi Fedoseev, TINRO, Magadan, USSR
John Hall, U. S. Fish and Wildlife Service, Anchorage, AK
Patrick McGuire, Marine Mammal Division, Seattle, WA
Carleton Ray, Johns Hopkins University, Baltimore, MD

Probably the same animals.

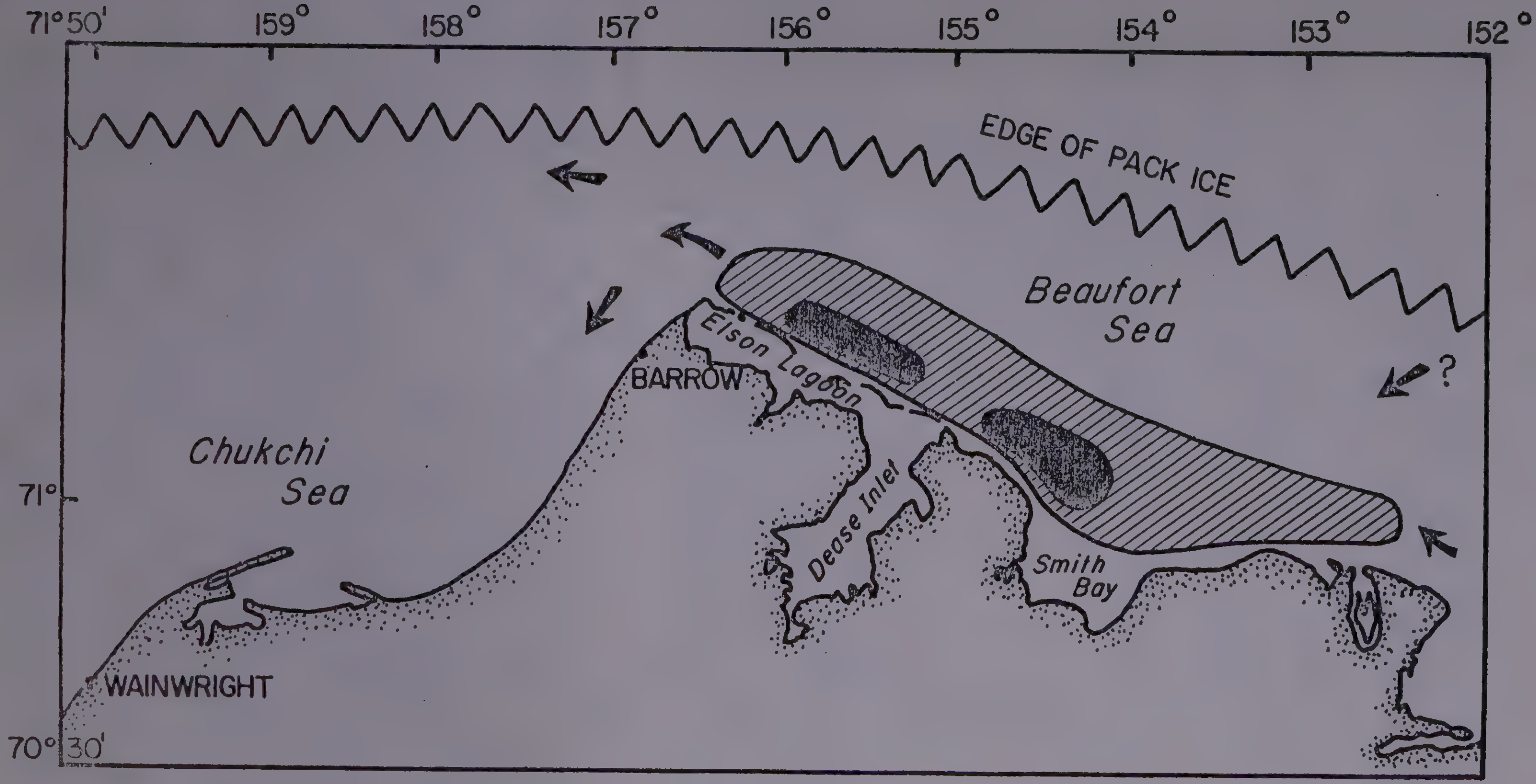


Figure 6. Area map of the northwest coast of Alaska depicting the region where bowhead whales concentrate during the fall. Darkened areas are areas of highest density; hatched areas, where animals are less dense. Movement into and out of this region remains unclear.

Table 3. Sightings of bowhead whales in the southern Chukchi and northern Bering Seas west of the US-USSR 1867 Convention line in the fall of 1974 and 1975. Data supplied by Dr. A. A. Berzin, TINRO, Valdivostok, U.S.S.R.

General Location	Number of bowheads
NW of St. Lawrence Island	3
SW Bering Strait	5
Bering Strait	2
NW of Bering Strait	4
NW of Shishmaref (US sector)	3
NE of Chukotski Peninsula (approximate)	
Cape Serdzekamen	1
Cape Chautau	20
Kolyuchin Island	60
Cape Vankarem	60
Cape Syeverni	23

Many bowheads apparently migrate to the northern coast of Siberia in the fall before moving south through the Bering Strait. Since few animals are reported to occur along the Siberian coast during the spring (G. Fedoseev, V. Golt'sev and A. Berzin, pers. comm.), the majority of animals appear to move north into the eastern Chukchi Sea in the spring and during the fall south into the western Chukchi Sea. Additional fall sighting data from the Chukchi Sea is needed.

Beluga whales

Spring 1976 counts. Aerial survey and ice station data on beluga whales along the northwest coast of Alaska during the spring of 1976 are summarized in Table 1 and Figure 7. The mean number of belugas seen per day for 19 aerial survey days from 29 April to 20 June 1976 was 54 (SEM = 12.4), n=19. Assuming an equal chance that belugas would be encountered on any of the 33 days not surveyed, a minimum estimate of 2,800 animals migrated past the northwestern coast during the survey period. This value was determined from 33 days not surveyed X 54 animals/day + 1,020 actually seen = 2,802. The 93 flying hours (some of which were not spent over the lead) during the 19 survey days represented only 20% of the total hours accruing between 29 April and 20 June.

Any determination of the total number of belugas which may have migrated past Barrow, based on 1976 aerial survey data, is biased because:

1. Duplicate sightings occurred on the same day.
2. We do not know if belugas migrate with any periodicity.
3. A detailed analysis of offshore sighting data has not been completed. Preliminary findings indicate that belugas use offshore leads.

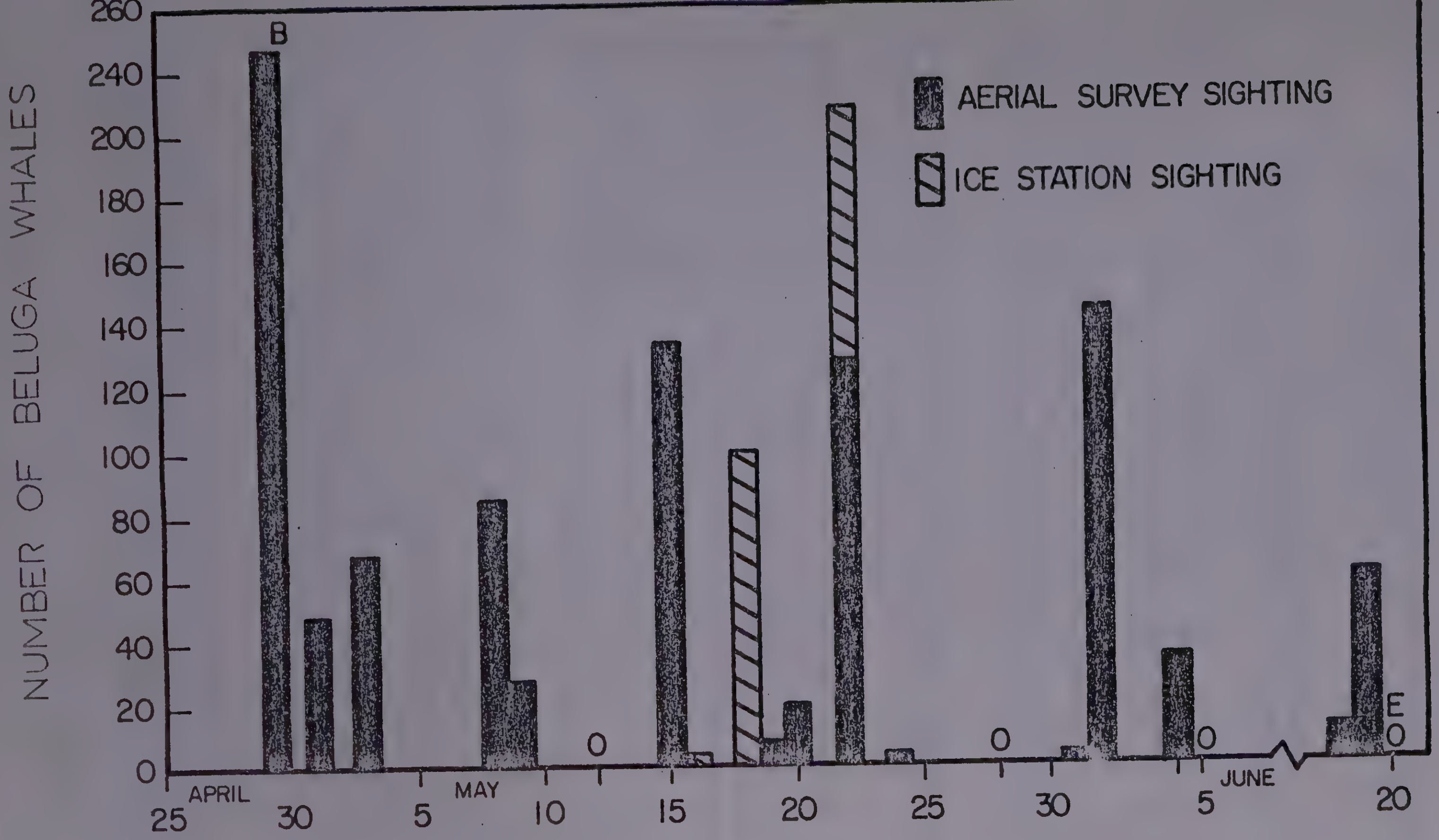


Figure 7. Numbers of beluga whales observed during aerial and ice-based surveys along the shore-fast ice lead between Barrow and Wainwright, Alaska, during spring 1976. B and E denote the dates of first and last aerial surveys. O's denote aerial surveys during which no belugas were observed.

4. The variability between sample days, which indicates clumped migratory patterns, makes extrapolation to other times of a survey day difficult.

5. Animals under the water or ice are overlooked. Also, belugas appeared to avoid our approaching aircraft. McVay (1973) reported similar behavior.

Caution should thus be exercised in using any value as an estimate of the total number passing by the vicinity of Barrow during the sample period.

Distribution. No pattern of numeric distribution with respect to time occurred in the data (Table 1). As many belugas were seen during the last part of the season as during the first part. The fact that 24% (248) of the total scored (1,020) was seen on the first survey day helps to confirm our feeling that belugas may migrate somewhat earlier than bowheads.

Our data also suggest that belugas use offshore leads with greater frequency than do bowheads (Figures 5 and 8). Additional offhsore surveys during 1977 should help to confirm this possibility.

Sightings of beluga whales in the Bering Sea and southern Chukchi Sea during the spring are reported in Table 2. Most observations occurred in the northern Bering Sea; however, more surveys were conducted there. Carleton Ray (pers. comm., RU 34) reports seeing over 300 beluga whales northwest of Port Moller in Bristol Bay on 13 April 1976. We do not know whether this group, and perhaps the group observed by us in a small polynya on 9 April (Table 2) are part of the "resident" population in Bristol Bay. Ray (pers. comm.) reports that approximately 47 beluga whales were observed northwest of St. Matthew Island in April 1975. We also do not know whether this group is strictly local or contains animals that migrated north past St. Lawrence Island.

Fall sightings. Few sightings of belugas have been made during our 1975 and 1976 aerial surveys of the Chukchi and Beaufort Seas. Sightings by other researchers have been more frequent. In September 1974, Ray (pers. comm., RU 34) sighted 23 belugas in the western Beaufort Sea northeast of Pt. Barrow. His most significant observation occurred in the pack ice in the area of 73°00' N. Latitude, 162°00' W. Longitude, where "a thousand or more" belugas were seen over the continental slope. In October 1975, Ray reported seeing 175-180 beluga in the southern Chukchi Sea just east of the US-USSR 1867 Convention line. Data collected in the fall suggest that belugas are spread throughout the Chukchi Sea.

Belugas are known to occur in rivers and estuaries in Bristol Bay, Norton Sound (Yukon River delta), Kotzebue Sound, and along the northwestern coast of Alaska. We need to determine whether these groups represent local populations or whether intermixing occurs in the Bering Sea during the winter months.

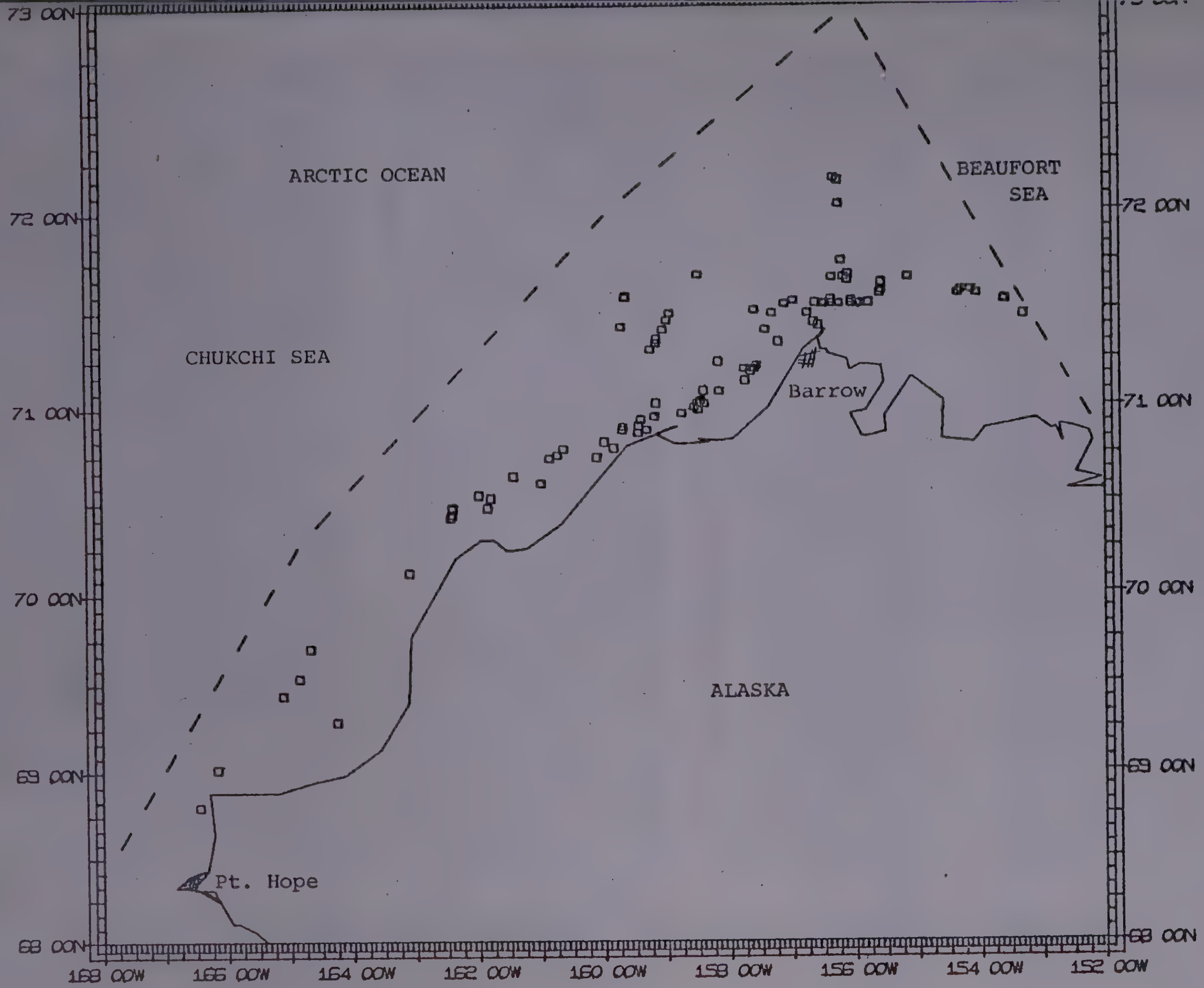


Figure 8. Spring 1976 aerial survey sightings of beluga whales, Delphinapterus leucus, along the northwest coast of Alaska. Dashed line represents the maximum extent of offshore surveys.

Comparison of survey methods

More beluga whales were seen during aerial surveys (total = 1,020) for the time spent sampling (about 93 hours) than were observed by the ice camp crew (total = 309 during 422 hours) (x^2: $P<0.001$). For this reason, aerial surveys were considered more efficient (numbers of animals per unit of time) for observing beluga whales. The same result occurred for bowheads. That is, more bowheads were seen during a unit of time in the air than on the ice (x^2:$P<0.01$). However, flight time is more costly, and it is more difficult to design a statistically reliable sampling technique for aerial surveys than for ice camp work. Additional analyses of the data are needed, however, because duplicate sightings undoubtedly occurred during aerial surveys, thus confounding any interpretation.

An additional test was performed to determine if there was any difference between the number of bowheads seen versus belugas when comparing aerial survey and ice camp counting methods. More bowheads than belugas were seen from the ice than expected (x^2:$P<0.001$). It would appear, then, that more reliable index of abundance data will be forthcoming for bowheads from ice camp sightings, and for belugas from aerial survey sightings.

Conclusions and Recommendations

The question of bowhead population abundance remains unanswered. From data collected in 1976 a total estimate cannot be made. Given a minimum population level of "...only a few thousand at most..." (Rice, 1974:193), fewer bowheads have been seen in the eastern Beaufort Sea (e.g., Banks Island-Mackenzie River delta area) than would be expected if most animals migrate east past Pt. Barrow in the spring. Since they have traditionally been hunted in the northern and western Chukchi Sea during the summer (Cook, 1926; Townsend, 1935; and others), it seems reasonable to predict that some bowheads remain in the Chukchi Sea or migrate to that area later in the spring (i.e., June-July). Future projections of abundance may have to take into account either a delayed or truncated migration.

Although a limited amount of data exists from one year of field work, evidence indicates that the bowhead whales which do migrate into the Beaufort Sea in the spring do so offshore rather than along the coast (Figure 9). We feel that at least some bowheads (perhaps most) migrate north through the pack ice to Banks Island, Canada, and then move south to the western Canadian coast in the summer. This hypothesis is based on five clues: 1) NOAA satellite photographs for 1974, 1976 and 1977 indicate that leads form offshore in a direct line from Pt. Barrow to Banks Island (Marko, 1975), whereas the lead(s) running east and west along the north coast of Alaska are less persistent; 2) bowheads appear to arrive at Banks Island earlier in the year (May) than at the Mackenzie River delta (Sergeant and Hoek, 1974; Fraker, 1977); 3) no sightings have been made in the spring and early summer for the nearshore leads along the northern coast of Alaska (although bad weather has prevented extensive aerial surveys); 4) Eskimo whaling occurs along the northeastern coast of Alaska in the fall, but not in the spring; and 5) commercial whalers overwintering at Herschel

Island, Canada, in the late 1800's reported finding very few bowheads in open water in the early summer along the northeastern coast of Alaska. Rather, the animals were found near the southwestern coast of Banks Island (Cook, 1926). This hypothesis should be tested because, if true, bowheads would be more vulnerable to Beaufort Sea oil and gas development activities in the fall than in the spring.

The fall migration of bowheads that spend summer in the eastern Beaufort Sea is along the Alaska coast westward to Point Barrow and then into the Chukchi Sea (Figure 8). The waters off Cape Simpson and Smith Bay (71°-71°20' N. Latitude, 154°-156° W. Longitude) have been identified as a potential "critical habitat" for the bowhead (Figure 6).

On 8 May 1976, copulatory behavior was photographed northeast of Pt. Barrow (Figure 10). To our knowledge, this observation is the first physical evidence of this type of reproductive activity in bowheads. A more detailed account of this occurrence is in preparation. On the same day, an apparent female and young of the year calf (less than half the size of the cow) were photographed (Figure 11). Although we are not certain that the northern Bering-southern Chukchi Seas and Beaufort Sea areas are the breeding grounds for the bowhead, copulation and parturition within the species occur during the northern migration and in or adjacent to the oil lease sites (i.e., Norton, Hope and Beaufort basins).

Evidence indicates that some beluga whales migrate farther offshore than do bowhead whales in the Chukchi and Beaufort Seas, and that belugas may not be as restricted from moving into the pack ice as first thought. Also, numerous convex impressions made by belugas in thin ice were observed (also see McVay, 1973), indicating that (directional) movement may occur under thin or in fractured ice.

General surveys for beluga whales should shift to localized studies after the FY 77 field season. It would seem to be more cost productive to study this species at specific locales within the oil lease areas (e.g., in Kotzebue Sound June-August, during the breeding season; or in Norton Sound and Bristol Bay in the summer). Development of a tagging or radio tracking program should provide a means of better identifying local and regional beluga movements, and of identifying breeding and calving areas as well as periods of feeding.

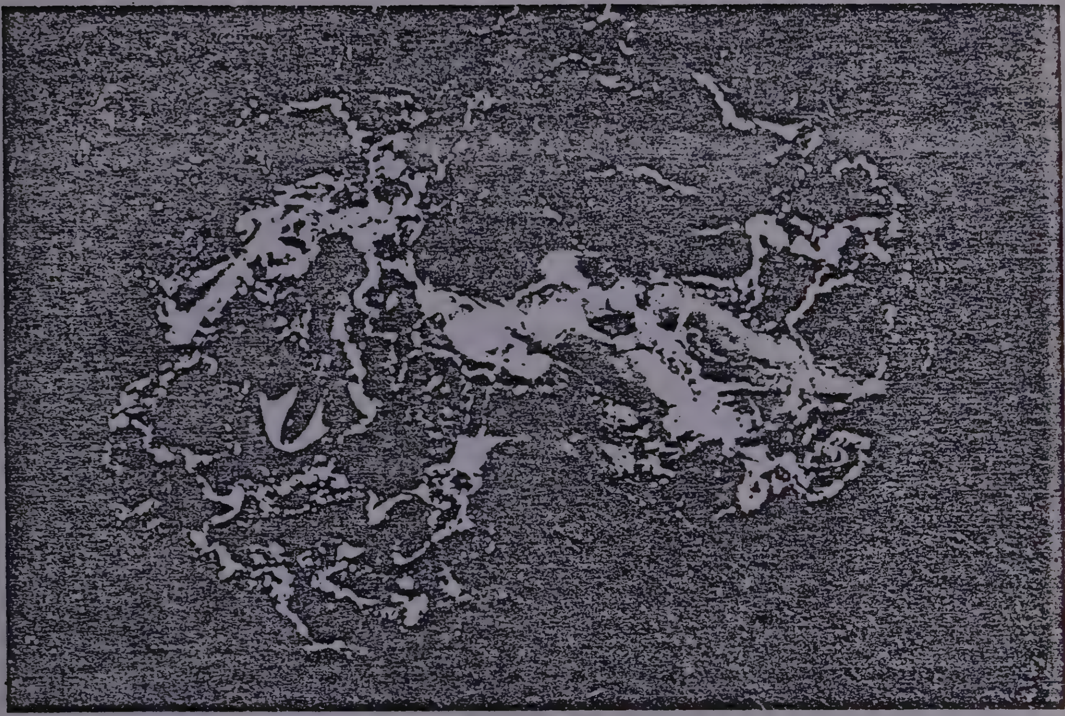


Figure 10. Seven bowhead whales engaged in copulatory activities. Photographed by B. Krogman, 8 May 1976, northeast of Pt. Barrow, Alaska.

Figure 11. Apparent female bowhead whale with young of the year calf. Photographed by B. Krogman, 8 May 1976, northeast of Pt. Barrow, Alaska.

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Pilots and staff members of the Naval Arctic Research Laboratory, Barrow, Alaska, cooperated with us by providing logistics support. Especially helpful was Richard Heyme, who provided us with a hydrophone for use in determining presence of certain marine mammals near our ice camp.

Any success we had on the ice during the 1976 spring season was due in part to the hospitality extended to us by Eskimos from Barrow. We very much appreciated their assistance, particularly in the identification of unsafe ice conditions.

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